Research Article Journal of Orthoptera Research 2025, 34(2): 223–232

Long term effect of dune fixation by three shrub species on vegetation and Orthoptera communities in arid dunes of Algeria

Bent El Hadi Sba[1], Imene Djemai[2], Daniel Petit[3], Atika Guendouz Benrima[4]

1 Faculté des Sciences de la Nature et de la Vie, Université Ziane Achour, Djelfa, Algeria.
2 Département des biotechnologies et agroécologie, Faculté des sciences de la nature et de la vie, Université Blida1, Blida, Algeria.
3 Faculty of Science and Technology, University Limoges, LABCiS, UR 22722, F-87000 Limoges, France.
4 Département d'agronomie, Faculté des sciences de la nature et de la vie et sciences de la terre, Université de Ghardaia, Ghardaia, Algeria.

Corresponding author: Atika Guendouz Benrima (atiguen@yahoo.fr)

Academic editor: Michel Lecoq | Received 25 September 2024 | Accepted 29 January 2025 | Published 7 July 2025

https://zoobank.org/7C85B342-EB7D-4FEF-ACE0-21B96768BB82

Citation: Sba BEH, Djemai I, Petit D, Guendouz Benrima A (2025) Long term effect of dune fixation by three shrub species on vegetation and Orthoptera communities in arid dunes of Algeria. Journal of Orthoptera Research 34(2): 223–232. https://doi.org/10.3897/jor.34.137800

Abstract

The present work analyzed flora and Orthoptera communities in three different plantations in the arid area of El Mesrane, Djelfa Wilaya, Algeria that begun 31 years earlier as means of fixation. The plantations consisted of retam (*Retama raetam* (Forssk.) Webb), tamarix (*Tamarix gallica* L.) and prickly pear cactus or opuntia (*Opuntia ficus-indica* (L.) Miller). Samplings performed in 2014 recorded 46 plant species and 32 Orthoptera species of which members of the Acrididae family were dominant. Community indices showed a decreasing gradient for both flora and Orthoptera from the retam to the opuntia to the tamarix plantation. Likewise, a growing proportion of plants were linked to mobile sands in the same gradient. The retam plantation having the highest flora diversity is mainly due to the therophytes of European open tufts and plants belonging to perennial xerophile fallow lands. The rarest species of grasshoppers are mainly present in the retam plantation, in contrast to the tamarix plantation where half of the characteristic species are among the most common, suggesting that specialist and generalist species are not distributed randomly but rather to the stability of the habitat.

Keywords

Arid climate, diversity, dune, flora, grasshoppers, rare sampling species

Introduction

The aridification of the environment is an important issue in several regions of the world including China (Li et al. 2014) and North Africa (Le Houérou 2000, 2002) as, in many cases, such aridification causes an increase in the amount of land surface covered with sand. Long-term studies are necessary to determine the best techniques for reversing the effects of aridification, and restoring ecosystem biodiversity (Li et al. 2004). Two complementary actions are used in such studies: mechanical stabilization and introduction of sand-binding vegetation (Khatteli and Akrimi 1997, Li et al. 2006).

Since 1962, Algeria has introduced various policies intended to fight desertification, such as the Green Dam project, the implementation of pastoral cooperatives, the promulgation of the pastoral code, and the program for improving land use (DGF 2004). These policies have yielded limited positive results because of difficulties motivating pastoralists and agro-pastoralists to participate in rangeland management (Nedjraoui and Bédrani 2008). Today, interest in reversing desertification appears to have increased as a result of initiatives of the High Office of the Steppe (HCDS) which is in charge of the steppe development programs (Kacimi 1996), aimed to increased forage supply by deferred grazing and pastoral plantations, mobilization of surface water, and introduction of renewable energy. Phytosociology (Djebaili 1984, Djebaili et al. 1989), geology, pedology (Pouget 1980), and climatology have all been taken into account when evaluating these Green Dam project interventions, which require significant human and material resources. In Djelfa and Bou-Saâda, an arid zone in central Algeria that extends northward to the Sahara, an experimental dune fixation project was launched in 1982 by the National Institute of Forestry Research (INRF) of El Mesrane. Its purpose was to fix the dunes and limit the advance of sand toward threatened cities and crop lands. Both mechanical (Khatteli and Akrimi 1997, Adamou et al. 2015) and biological fixation techniques were applied. For the latter method, reforestation is essential but requires choosing plant species appropriate to the ecosystem. Several bush species, including *Retama raetam* (Forssk.) Webb, *Tamarix gallica* L., *Tamarix aphylla* (L.) H. Karst, *Elaeagnus angustifolia* L., *Lycium shawii* Roem. & Schultz., and *Opuntia ficus-indica* (L.) Mill., have been used for biological fixation with varied results.

Most studies have investigated the effects of biological fixation on soil and flora (Le Houérou 1996, Neffar et al. 2013, Akkouche et al. 2014, Guerrache et al. 2014, Adamou et al. 2015), but the consequences on insect assemblages—particularly Orthoptera—have been poorly studied. These insects play an important role in food

Copyright *Bent El Hadi Sba et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

webs because they greatlyly contribute to providing vertebrates with food sources (Souttou et al. 2011, Guerzou et al. 2012). Consequently, they are good indicators of ecosystem health. To assess the efficiency of different bush species in El Mesrane, a study of flora and Orthoptera communities was conducted in 2013, 31 years after restoration works began in this region. It is well known that when the vegetation cover of a dune is scarce, insect richness is very poor as a result of unstable soil. With the development of vegetation in dunes, it is expected that its composition will be close to that associated with steppes (i.e., the climax vegetation found in arid areas).

Thus, the first objective of our study was to describe the plant and Orthoptera communities associated with the three main bush species used for dune fixation (retam, ramarix, and prickly pear cactus) and to determine which bush species produce the highest level of diversity. The significance of the current vegetation in the area was addressed using the complementary approaches of consideration of the phytosociology system, Raunkiaer's system of life forms, and our knowledge of plants' resistance to moving sand. The second objective was to test which Orthoptera assemblage among the three dune habitats was the most similar to those seen in steppe environments. The third goal was to decipher which of the three dune Orthoptera assemblages was the most stable by taking rare species into account.

Materials and method

Site description.—The choice of specific dunes in the region of El Mesrane was motivated by their special microclimates and ecological diversity, and one of the richest diversity of fauna and flora in the Djelfa wilaya (i.e., territorial division of Algeria) (Benmadani et al. 2011). The study area is located 30 km north of Djelfa city on National Road N1 and 20 km south of Hassi-Bahbah city between 860 and 880 m.a.s.l. It is bounded on the north by a sebkha (vast salt flat), on the south by the mountains of Ouled Nail, on the east by dunes, and on the west by National Road N1. For the period 1984–2014, the monthly precipitation curve crosses the temperature curve in the system of Bagnouls and Gaussen (1953), indicating that the dry season lasts 10 months from February to November, with intense drought from June to September. The Emberger pluvio-thermic quotient during the same period is Q3 = 24.74, with P = 249.37 mm, M = 36.37 °C, and m = 1.66 °C (M being the maxima means of the hottest month and m the minima means of the coldest month). This value was used to draw Emberger's climagram to determine the bioclimatic area within a Mediterranean context. As a result, the study area was revealed to belong to the upper arid stage with fresh winter.

Description of the vegetation.—The vegetation of the El Mesrane dunes in this study is characterized by species common in sandy steppe and enriched with psammophyte species (plant species associated with sand) such as *Stipagrostis pungens* (Desf.) De Winter (= *Aristida pungens* Desf.). In wadi (i.e., inter-dune zones), several hygrophilous species grow, such as *Phragmites australis*. Before fixing, the soil of the dunes was almost devoid of vegetation, but after the establishment of fixing species, natural vegetation progressively colonized up to 65% of the dunes' surface. The vegetation cover varies in space and time according to the interaction of climate and soil factors.

To determine flora biodiversity, we conducted an extensive sampling to inventory all plant species present in the three plantations of *Retama raetam*, *Tamarix gallica*, and *Opuntia ficus-indica*. Sampling locations were chosen in floristically homogeneous environments representative of all groups assigned to specific ecological affinities.

Vegetation surveys were conducted during the months of both March and April of 2013 and of 2014. We counted the number of individuals along a 10-meter rope ten times in order to quantify each plant species within a uniform area of 100 m². A total of 30 plots on three plantations along the project area were sampled (i.e., 10 per habitat).

Plant species identification was undertaken in the laboratory of the Desertification Control Station of the INRF in Djelfa using the keys from floras of Quézel and Santa (1961, 1962) and of Ozenda (1991). Nomenclature was subsequently updated using Tela-Botanica electronic flora of North Africa (https://www.tela-botanica.org/flore/afrique-du-nord). The works of Julve (1998) and Kaabèche (2000) were used to assign plant species to the phytosociological database. For each sampling, the amount of a phytosociological class or alliance was quantified by summing the abundances of species belonging to the phytosociological group, resulting in 10 values per habitat. To interpret the psammophytes (i.e., plant species associated with sand in the dynamic processes of dune colonization), we used the results of Guerrache et al. (2014), which was conducted in the same area, who defined three groups: Group 1 and Group 2 are comprised of species growing on fixed sand on slopes protected from wind and under wind, respectively, and Group 3 is comprised of plant species found in recently fixed or not yet fixed dunes (see Appendix for the species content of each group). For each survey, we summed the abundances of species belonging to a given psammophyte group, resulting in 10 values per habitat. Raunkiaer's system of life forms (1934) was used to establish the number of species belonging to the categories of therophytes, hemicryptophytes (annual and biennial herbs, respectively), chamaephytes, and phanerophytes (ligneous plants with buds less or more than 25 cm above the ground, respectively). No geophytes were encountered.

Soil analysis survey.—A survey of soil analysis was conducted on the two extreme parts of the vegetation gradient (i.e., in the retam and tamarix plantations in spring 2012). In each habitat, 10 soil subsamples of 50 g each were taken (at a depth of 5 cm, just beneath a bush canopy, separated by intervals of at least 5 m) and then pooled. Electrical conductivity and pH were quantified using 5 volumes of distilled water added to 1 volume of substratum. The rate of organic carbon was calculated from the percentage of Carbon multiplied by the coefficient of 1.72 (Mathieu and Pieltain 2003). Carbonate content was determined using a Bernard calcimeter. Salt content (estimated by electrical conductivity) was low with similar values (0.4 and 0.3 mS/cm for the retam and tamarix plantations, respectively). Results were similar for the organic matter, which measured at 1.85% and 1.54% in the retam and tamarix plantations, respectively. Both plantations had a similar pH at ~7.9 and total CaCO3% at ~7.2.

Sampling of Orthoptera.—The quadrat method was used to sample Orthoptera. Within a homogeneous area of one ha in each plantation, three 3 × 3 m squares were randomly chosen for insect sampling using a sweep net. Monthly samplings were conducted in each site from the beginning of March to the end of December of 2014. Captured insects were collected in plastic bags on which the date and place of capture were noted. They were kept at 4 °C for their subsequent determination in the laboratory. Identification was made using the fauna study of Chopard (1943), and nomenclature was updated using the Orthoptera Species File (Cigliano et al. 2024) and the website of Louveaux et al. (2024). It should be noted that the low number of DNA barcoded Orthoptera species in Algeria (Moussi et al. 2018, Hafayed et al. 2023), particularly in the genera *Pyrgomorpha* and *Tmethis*, indicates a need for systematic studies.

To facilitate assigning the Orthoptera species to different habitats, we added the results of surveys by Benmadani et al. (2011) conducted on an uncharacterized dune zone of the same El-Mesrane locality and three surveys by Sba and Benrima (2017) on steppe vegetation of the Djelfa area: The Oued Sdar site (SDR) is an alpha steppe dominated by *Stipa tenacissima* that is well preserved, protected by fences against goat and sheep grazing, and host to 30 plant species; the Moudjbara site (MDJ) is a degraded alpha steppe dotted with *Pinus halepensis* where 25 plant species were recorded; and the El Merdja site (MER) is a pasture where the dominant species is *Lygeum spartum*, which is linked to gypso-calcareous soil surface and a thicker silt soil (>50 cm). Its greater number of plant species (55) is explained by the numerous ephemerophytes belonging to the *Arthrophytum scoparium* steppe, indicative of extreme aridity (see Table 1 for characteristics of the four stations considered in this study).

Data analyses.—For each habitat, the abundance of each species of Orthoptera was determined by the monthly cumulated number of specimens recorded in 9 m² quadrats. As noted above, three quadrats were chosen in each habitat type. The richness of each replicate was represented by the monthly cumulated number of encountered species. The significance of differences in plant and insect composition between the three habitats of the El Mesrane dunes was assessed using an analysis of similarity (ANOSIM, Clarke 1993) and the Bray-Curtis dissimilarity as a measure of distance. Comparisons of the abundances of phytosociological and psammophyte groups, of community indices, and of life forms between the three habitats were conducted using Kruskal-Wallis tests.

A correspondence analysis was conducted to reveal the association between insect groups and habitats (Benzecri 1992) and included data from the surveys carried out by Benmadani et al. (2012) and Sba and Benrima (2017) in a steppe environment in the same Wilaya of Djelfa. The latter surveys were carried out with the same protocol as ours (i.e., monthly on identical quadrat surfaces). The coordinates on the first 3 components provided by the correspondence analysis for both insects and habitats were subsequently considered to perform a cluster analysis, using Ward's method. As explained in Mahdjoubi et al. (2017), this clustering method provides a balanced distribution of objects in various groups.

To assess the rareness and commonness of Orthoptera species, we took into account the Algerian locality numbers recorded in the Museum National d'Histoire Naturelle (Paris) (Louveaux et al. 2024) dedicated to Acridomorpha. We retained a threshold of 8 species (common = around the fourth quartile and rare = around the first quartile) among the 35 species found in Djelfa Wilaya'. This method produces only an approximation given the incompleteness of the university's database, but it provides an objective view for comparisons. It should be noted that *Pyrgomorpha* cf *conica*, although common in El Mesrane, could not be considered as its specific status in the database of Louveaux et al. (2024) is controversial. All analyses were carried out using PAST software vers. 2.17 (Hammer et al. 2001).

Results

Qualitative assessment of the floristic composition.—In the vegetation surveys on the plantations of Tamarix, Retam, and Opuntia conducted during 2014, 46 species belonging to 22 families were recorded (Appendix 1). The five most abundant families, in decreasing order, are Asteraceae, Poaceae, Plantaginaceae, Brassicaceae, and Lamiaceae.

The vegetation of the studied area has diverse origins (Mediterranean, Saharo-Arabic, Saharo-Mediterranean, and endemic). Analysis of the floristic composition (Suppl. material 1: data 1) showed the dominance of the Mediterranean elements with a maximum in the Retama plantation (66.67%). The Saharo-Arabic, endemic, and Saharo-Mediterranean elements were almost equally represented in the Tamarix plantation, while the Saharo-Mediterranean elements prevailed in the Retam plantation and the endemic elements in the Opuntia plantation.

Quantitative aspects of the plant communities.—We verified the homogeneity of the vegetation of each plantation using a cluster analysis that took into account the plant composition of the 10 samples on the 3 plantations (Suppl. material 1: data 2). We also tested the significance of differences in plant composition of these samples using an ANOSIM. All the combinations of comparisons were revealed as significant with a p-value <0.01 (data not shown).

Based on 10 samples per habitat, the retam plantation hosts a significantly higher number of plant species with a lower dominance than the two other plantations, which do not differ from each other in this respect (Fig. 1). The abundance of plant species was also higher in the retam plantation than in the tamarix plantation and was highly variable in the opuntia plantation samples.

Psammophyte plant groups.—The plant groups, as defined by Guerrache et al. (2014), were found to have variable cover based on habitat (Appendix 1 and Fig. 2). The vegetation fixed on the dunes had the greatest cover in the Retam plantation and the lowest in the Tamarix plantation. For the Opuntia plantation, the cover was intermediary for the group protected from the wind and equal to that of the Retam plantation in the group exposed to wind. In contrast, the vegetation associated with mobile sand or recently colonized dunes had the lowest cover in the Retam plantation.

Raunkiaer's life form.—The flora in all the plantations was composed of 48% therophytes, 22% chamaephytes, 13% phanerophytes, and 9% hemicryptophytes. However, there were significant differences between plantations in the proportion of therophytes, which was approximately half in the Opuntia and Tamarix plantations and more than two-thirds in the Retam plantation (Kruskal-Wallis test, N = 30, p<0.001, Fig. 3). The same pattern was observed for hemicryptophytes, again with significant differences (p<0.01). Conversely, the chamaephytes were significantly reduced to less than one-tenth in the Retam plantation and constituted approximately a third in the other two plantations (p<0.001). There were

Table 1. Characteristics of the four sites considered in this study; climatic data calculated based on the 1983–2013 period.

Sites	Environment	Code	Altitude (m)	Longitude, Latitude	Annual precip. (mm)	m °C	M °C	Q2
El Mesrane	Dune cordon	**MES**	876	34°91'22"N, 3°06'43"E	249.3	1.66	36.37	24.6
Oued Sdar	Alpha steppe protected by exclosure	**SDR**	1235	34°28'22"N, 3°16'47"E	313	-0.3	33.7	31.6
Moudjbara	Degraded Alpha steppe with *Pinus halepensis*	**MOU**	1200	34°38'23"N, 3°18'56"E	278	0.3	33.9	28.4
El Merdja	*Lygeum spartum* steppe	**MER**	1077	34°65'21"N, 3°24'06"E	315	0.2	31.3	34.7

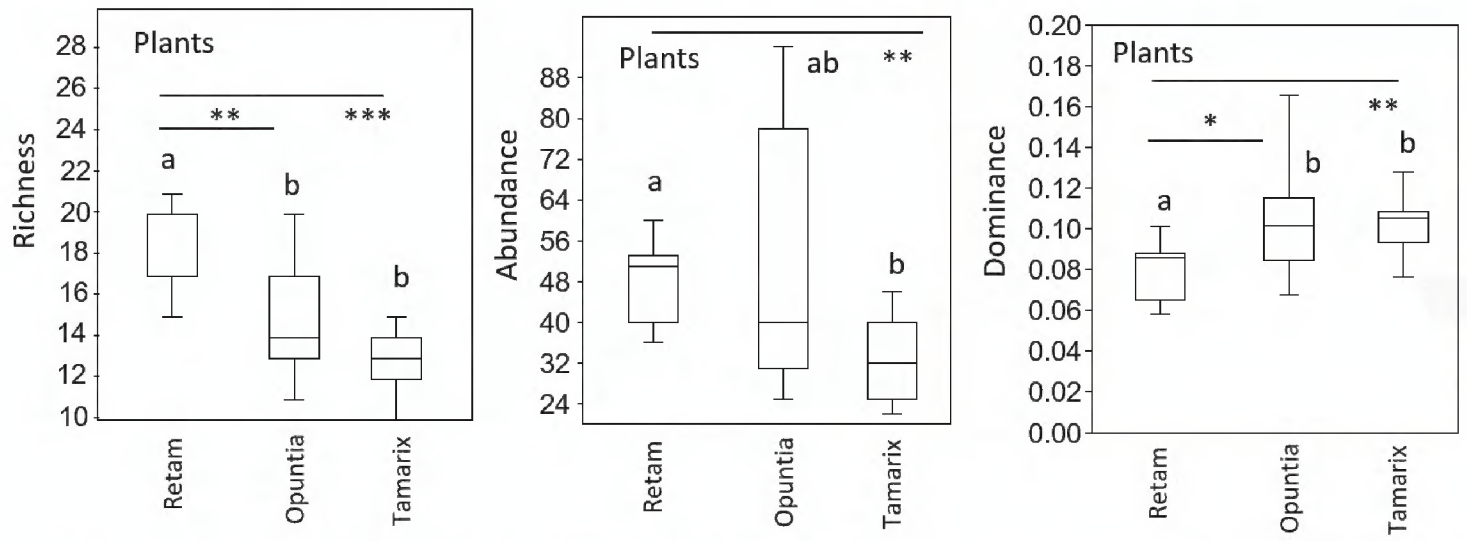

Fig. 1. Vegetation parameters of the three habitats. Different letters correspond to significant differences given by Kruskal-Wallis tests, N = 30; * p<0.05; ** p<0.01, *** p<0.001.

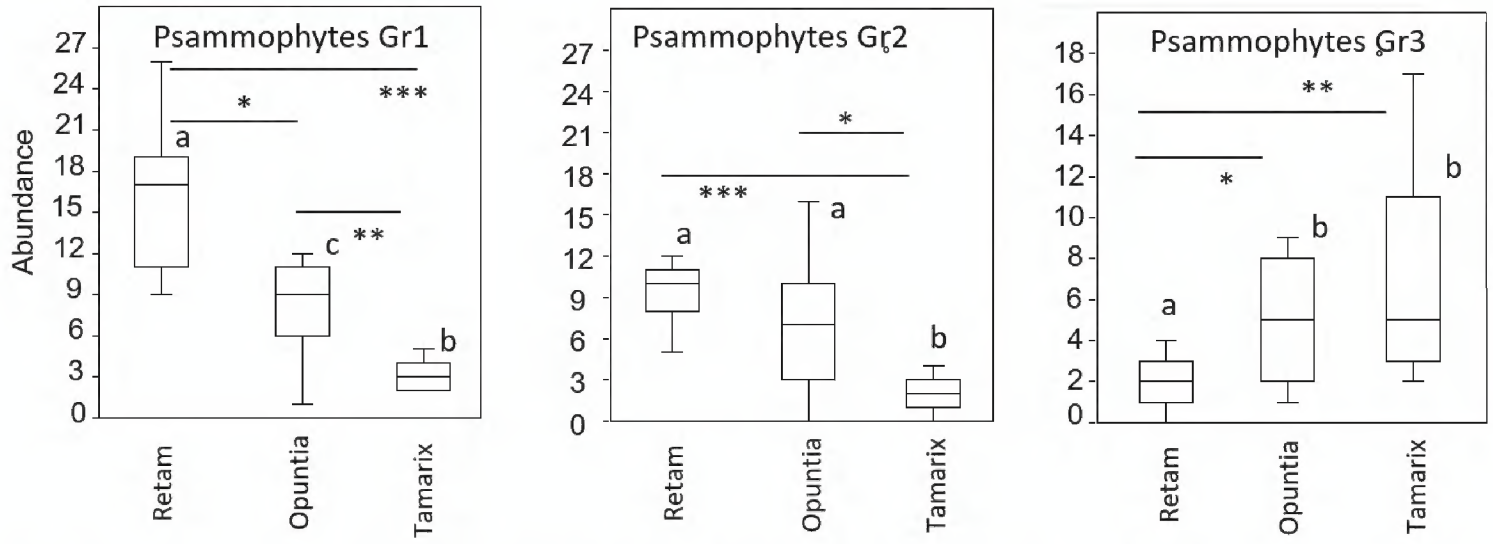

Fig. 2. Abundance of psammophyte groups in the three habitats. Gr1 = fixed vegetation on the slope protected from wind; Gr2 = fixed vegetation on the slope exposed to wind; Gr3 = vegetation on sand recently or not fixed. Different letters correspond to significant differences given by Kruskal-Wallis tests, N = 30, * p<0.05; ** p<0.01, *** p<0.001.

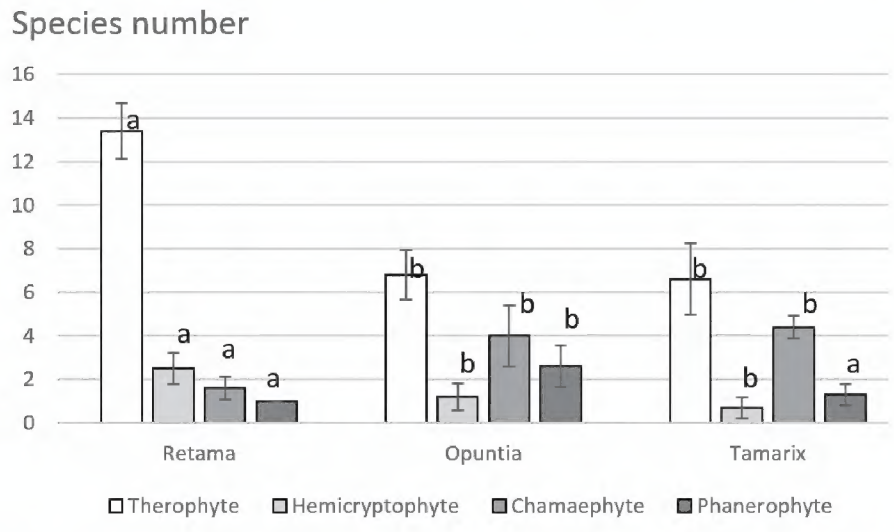

Fig. 3. Species numbers of the different life forms in the three habitats. For each life form, Kruskal-Wallis tests compared the 10 values in the three habitats (N = 30). Different letters correspond to significant differences.

significantly more phanerophytes species in the Opuntia plantation than in the two other habitats (p<0.001). The significance of the variation in the different life forms requires further analysis using a phytosociological approach.

Phytosociological classifications of the vegetation in the three plantations.—The percentages of plants belonging to the main alliances were calculated for each habitat using data from Appendix 1. The dominant orders and alliances were the vegetation developed on arid and Saharian dunes (*Calligono-Aristidetea*, the steppe assemblages of sub-shrubs and grass growing in tufts set at short intervals (*Lygeo-Stipetea*), and the subnitrophilous to nitrophilous annual European fallow land (*Sisymbrietalia officinalis*). A lesser

Table 2. Mean abundance of the main phytosociological groups in the three habitats.

Orders and alliances	Retam	Opuntia	Tamarix
Calligono-Aristidetea	6.3 a	17.8 b**	31.3 b***
Lygeo-Stipetea	12.5 a	14.0 a	0.0 b***
Onopordetalia illyrici	18.8 a	4.0 c***	0.0 b***
Stipo-Brachyp.+Tuberarietea	25.0 a	6.0 b***	6.3 b***
Sisymbrietalia officinalis	14.6 a	22.0 b*	18.8 a
Stellarietea + Papaveretalia	10.4 a	10.0 a	6.3 b*

The different letters correspond to significant differences, given by Kruskal-Wallis tests, N = 30, *p<0.05; **p<0.01, ***p<0.001.

represented assemblage was the Mediterranean perennial fallow xerophilous land (*Onopordetalia illyrici* subsp. *illyrici*). For the sake of clarity, we grouped the annual species characteristic to European open turfs (*Stipo capensis - Brachypodietea distachyi* and *Tuberarietea guttatae*) and the annual species linked to crops (*Stellarietea mediae* and *Papaveretalia rhoeadis*). The abundances of observed orders and alliances for each habitat are shown in Table 2.

It is clear that the vegetation linked to retam mainly differs from the vegetation of the two other habitats by its high percentage of annual species characteristic to European open turfs. The hemicryptophytes in the retam plantation were primarily from the *Lygeo-Stipetea* steppe group and from the perennial xerophilous fallow land *Onopordietea illyrici* group. The higher abundance of chamaephytes—well developed in the opuntia and tamarix plantations—is linked to the vegetation developed on arid and Saharian dunes (i.e., *Calligono-Aristidea*). The high richness of plants belonging to this last group in the tamarix plantation is also

related to the annual species of the *Calligono-Aristidetea*. The phanerophytes are mainly associated with the Mediterranean matorral of the *Pistacio lentisci - Rhamnetea alaterni*, present in the opuntia plantation but absent in the other two.

Orthoptera.—An inventory of Orthoptera in the three habitats of El Mesrane is presented in Appendix 2. Of the 32 species recorded, one belongs to Ensifera, family Tettigoniidae (*Platycleis affinis*), and the remaining species to Caelifera. These Caelifera belong to four families: Acrididae (24 species), Pamphagidae (4 species), Pyrgomorphidae (2 species), and Dericorythidae (1 species). In the Acrididae, members of 6 sub-families were present: Oedipodinae (15 species), Gomphocerinae (3 species), Acridinae (2 species), Egnatiinae (2 species), Calliptaminae (1 species), and Cyrtacanthacridinae (1 species). The cumulate monthly richness (mean and SD) of Orthoptera was 20 ± 2.6, 19.6 ± 1.2, and 12 ± 3.6 species in the retama, opuntia, and tamarix plantations, respectively. Likewise, the cumulate monthly abundance of Orthoptera was 86 ± 27.9, 58 ± 16.1, and 33 ± 14.1 individuals in the retama, opuntia, and tamarix plantations, respectively. As shown in Fig. 4, 12 species were shared by the three habitats, while 7, 4, and 1 were specific to the retam, opuntia, and tamarix plantations, respectively.

To compare the assemblage parameters of the three plantations, we first looked at the monthly sampling records for each plantation. Comparisons of the monthly variations in Orthoptera abundances were conducted using ANOVAs with repeated measures. The results showed that the richness and abundance of Orthoptera were significantly lower in the tamarix plantation than in the other two plantations (Fig. 5).

To test whether the grasshopper assemblages differed in composition, we submitted the monthly samplings in the three plantations to an ANOSIM. The result revealed non-significant differences between the compositions of the three habitats ($p > 0.12$ in all combinations) in contrast to the floristic situation. Since the origin of these unexpected differences could be the result of a set of equally distributed dominant species, we suspected that some species significantly differed in abundance based on plantation. The ANOVAs showed that 8 species differed significantly in their abundance between habitats, with the highest values being recorded in the retam plantation (Fig. 6). In contrast, only two species showed higher values in the opuntia plantation, and none were associated with the tamarix plantation.

To determine the affinity of Orthoptera on a larger scale, we added the results of the survey performed on another dune zone (Benmadani et al. 2012) and those of three other surveys of arid steppe landscapes (Sba and Benrima 2017; see material and method for description). Cluster analysis of the different habitats and

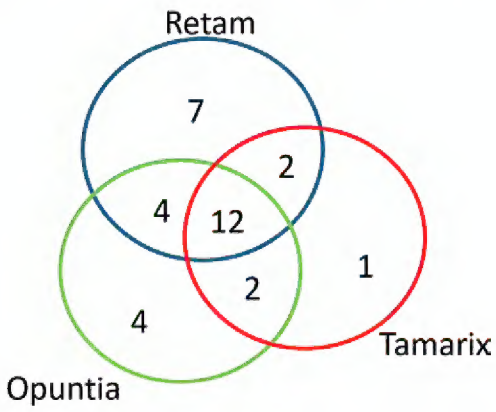

Fig. 4. Venn diagram of the Orthoptera distributed in the three habitats.

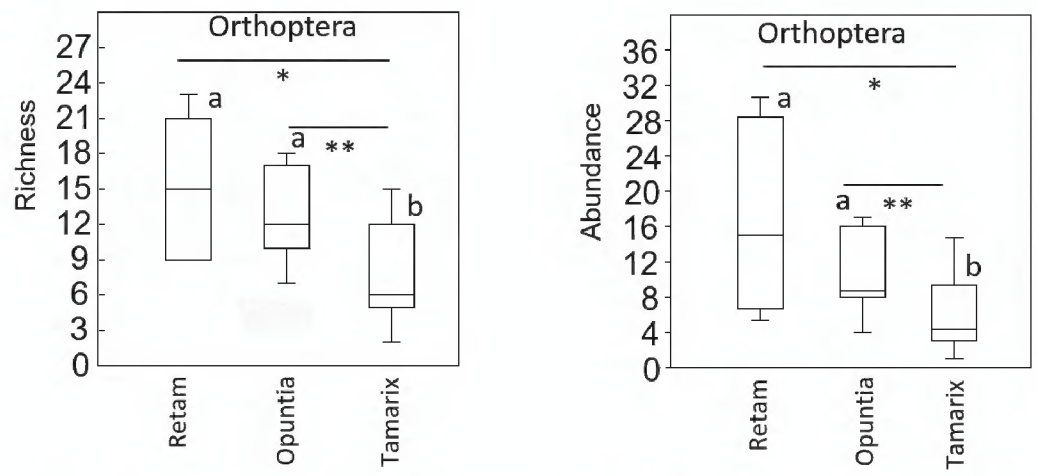

Fig. 5. Variations in Orthoptera monthly richness and abundance between the three habitats. Different letters correspond to significant differences (ANOVA with repeated measures, N=21) with *p<0.05; **p<0.01.

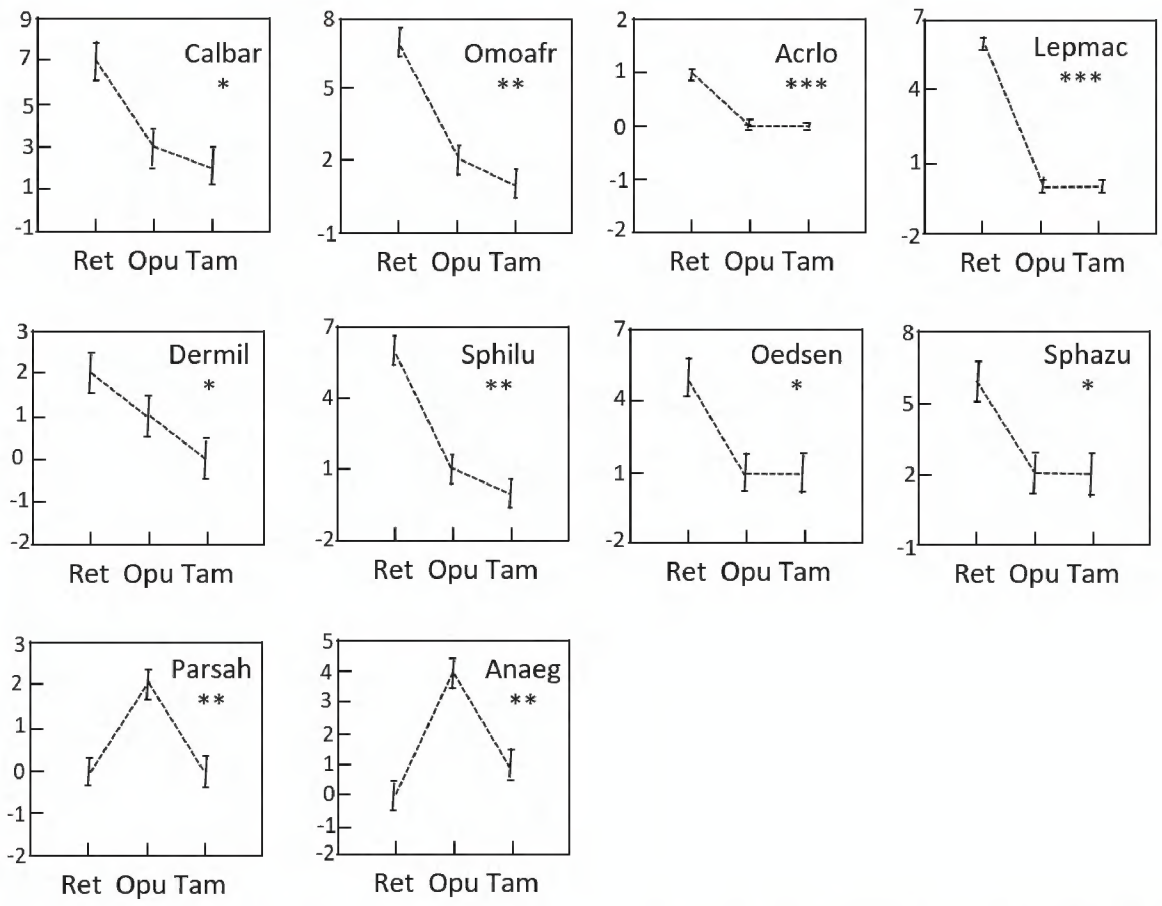

Fig. 6. Variations in Orthoptera abundances (monthly cumulated specimen number per quadrat replicate) in the three habitats. Significance ws given by ANOVAs, N = 9, with *p<0.05; **p<0.01. Abbreviations: Ret = *Retama raetam*; Opu = *Opuntia ficus-indica*; Tam = *Tamarix gallica*.

Orthoptera species shows three main groups (Fig. 7): 4 species linked to the protected Alpha steppe of Oued Sadr, 13 to the Retam plantation of El Mesrane, and the rest linked to the uncharacterized dune of El Mesrane, the *Lygeum spartium* steppe of El Merdja, the tamarix and opuntia dunes of El Mesrane, and the degraded alpha steppe of Moudjebara. This indicates the originality of the insect community in the retam plantation and the close proximity between the fauna of the tamarix and opuntia plantations of El Mesrane and the degraded alpha steppe of Moudjebara.

The distribution of rare species in the cluster analysis was not random when we compare their abundance in the insect assemblages in the tamarix and opuntia plantations with those in the retam plantation. There were 4 rare species among the 12 associated with the retam plantation, but only one and none in the opuntia and tamarix plantations, respectively. Half of the 6 species associated with the opuntia plantation and a third of the species characteristic of the retam plantation are among the most common. No common species were recorded in the opuntia plantation.

Discussion

Over the last 40 years, the steppe landscape in Algeria has dramatically changed, affecting the floristic composition and functioning of the ecosystem (Aidoud et al. 2006, Nedjraoui and Bédrani 2008). The sand dunes are characterized by unstable soil and poor organic matter (FAO 1988). The focus of a restoration of such an ecosystem is to limit the speed of dominant winds through the presence of bushes or artificial fences. Artificial fences must be pitted so as to prevent the apparition of whirlwinds, reducing sand mobility and favoring a firm establishment of vegetation. In semiarid areas, the succession process can last dozens of years when perturbations (due to grazing, for example) occur, but the process is faster if artificial fences are present (Zhang et al. 2015). The beneficial effects of bushes can be enhanced if the surface of the dune is covered with a protective layer of artificial or plant-based origin. The natural degradation of this layer leads to an accumulation of organic matter and nutrients that favors the development of plants (Li et al. 2006). Below, the characteristics of the vegetation of each plantation are discussed, followed by a discussion of the related Orthoptera communities in terms of diversity and species rareness.

Bush plantations and vegetation characteristics.—The vegetation of each plantation was examined using several complementary approaches, including consideration of community parameters, phytosociological systems, life forms, and resistance to sand mobility. The combination of these approaches contributes to the description and, more interestingly, the interpretation of the differences between the plantations.

Although the three plantations were synchronic, there was a gradient in the colonization process of the dunes evidenced by the decreasing proportion of plants characteristic of open and mobile sand. Based on the use of the groups defined by Guerrache et al. (2014), the species characteristic of mobile sand (*Euphorbia guyoniana*, *Ononis natrix*, *Saccocalyx satureioides*, *Stipagrostis pungens*, and *Pseuderucaria teretifolia*) showed decreasing abundances from the tamarix plantation to the opuntia and retama plantations. If

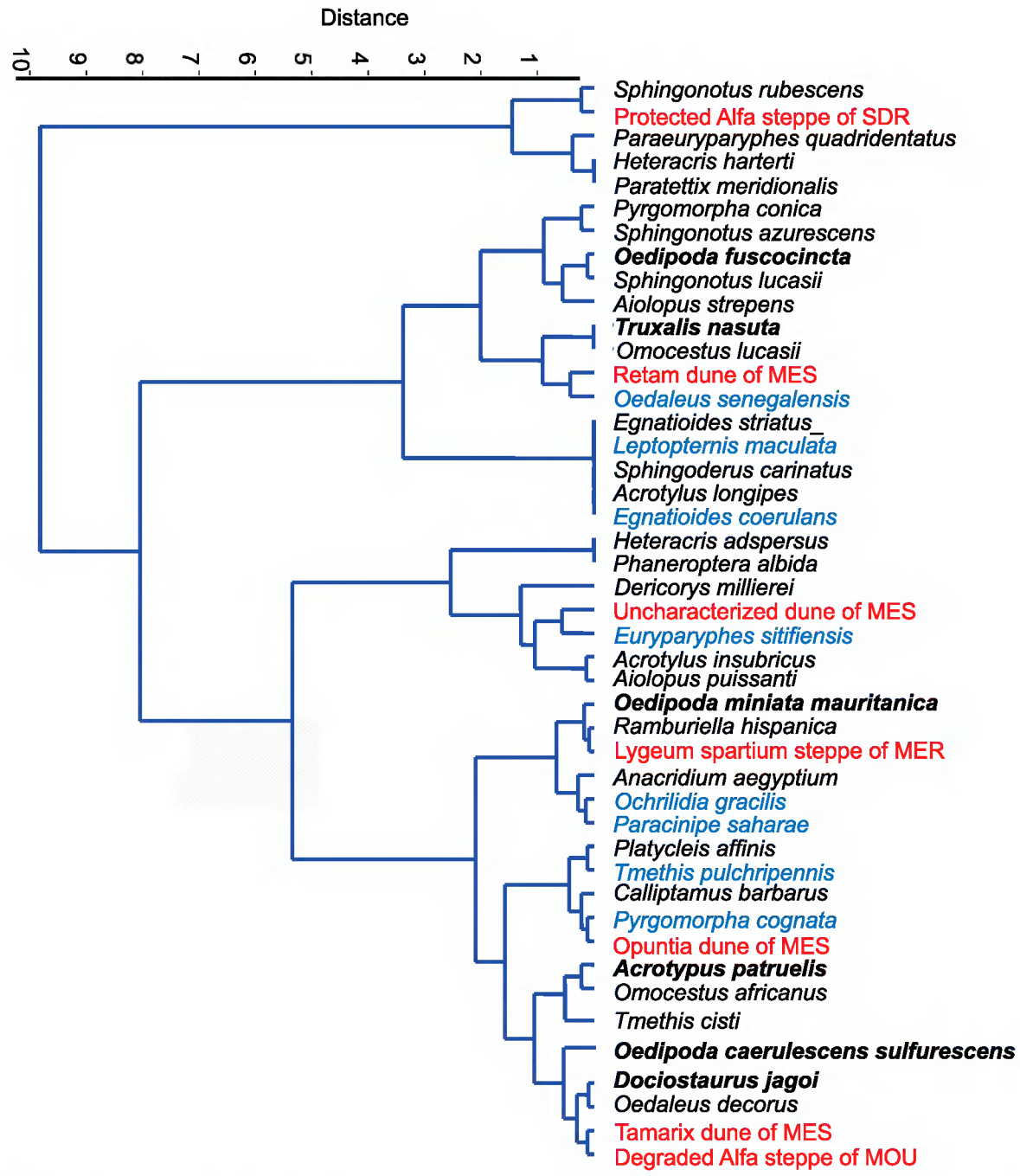

Fig. 7. Cluster analysis of the 37 Orthoptera recorded in the seven habitats of Djelfa Wilaya. The rarest species are in blue characters, and the most common ones in bold characters. Abbreviations: MES = El Mesrane; SDR = Oued Sda; MOU = Moudjbara; MER = El Merdja.

community parameters are considered, the retam plantation again showed the highest values of richness and abundance and the lowest dominance. In contrast, the tamarix plantation offered the most opposite values in these parameters, although largely overlapped with that of the Opuntia plantation. The better performance of retam over tamarix in the growth of bush species for the restoration of dunes is not a surprise given several results observed in Algeria (Akkouche et al. 2014, Adamou et al. 2015). In semi-arid coastal dunes of Spain, Muñoz-Vallés et al. (2014) found that the presence of *Retama monosperma* (close to *R. raetam*) enhanced carbon, nitrogen, and other nutrient mineral elements in the soil, as well as flora diversity, but eliminated several plant species specific to dunes.

Beyond these observations, we present below a characterization of the plant species growing specifically in the retam plantation. Note that the global proportion of therophyte and hemicryptophyte life forms in the complete dune complex of El Mesrane was approximately 56% and 7%, respectively, which are values that conform to what has been calculated in Saharan, arid, and semi-arid areas in Morocco (Daget 1980).

The retam plantation hosted more therophytes and hemicryptophytes and fewer chamaephytes than the two other plantations. The use of phytosociology allowed an accurate interpretation of the vegetation recorded and hence aided in determination of the environmental factors involved in the variation in Orthoptera diversity. The retam plantation held more species characteristic of European open turfs and perennial xerophilous fallow land, which are herbaceous vegetation that develops in the first stages of succession or that has a short life cycle. In the retam plantation, the proportion of nitrophilous species from the *Sysimbrietalia officinalis* group was less than in the Opuntia plantation, indicating that retam does not increase the nitrogen content of the soil more than tamarix or opuntia. This result is counterintuitive, as *Retama raetam* belongs to Fabaceae, known for its nitrogen fixation through *Rhizobium*-associated roots. As no protection against grazing was implemented, we can hypothesize that the three habitats were randomly visited by sheep and goats that equally enriched the soil with organic matter (Neffar et al. 2013). This could explain the comparable values obtained in our survey. Thus, what is the most likely origin of the beneficial effect of retam on the flora? We hypothesize that it is the layer of fallen leaves under the canopy of retam bushes that prevents the sand from moving and therefore promotes the germination of therophytes in the spring.

Bush plantations and Orthoptera diversity.—Our investigations recorded 32 species of Orthoptera, significantly more than the previous inventory of 20 species performed by Benmadani et al. (2011) in the same dune ecosystem of El Mesrane. However, of the three species in their list that are absent from ours, the first one, *Heteracris adspersa*, had already been noted by Grunshaw (1991) in the same locality. The second one was the very rare bush-cricket *Phaneroptera albida* as it was only recorded before in Morocco from Draa valley and Tafilalet (Chopard 1943). In contrast, the third one, *Ochrilidia tibialis*, could have been confused with another species of the genus, since it was considered absent from North Africa by Louveaux et al. (2024).

The abundance and richness of Orthoptera fauna in the retama plantation remain unexplained. A priori, it seems logical that these features are linked to the rich flora recorded in dune ecosystems in general. This view is supported by previous works in Algeria (Moussi et al. 2011, Sobhi et al. 2013, Mahloul et al. 2016, Betina et al. 2017, Bouziane et al. 2023). The majority of Orthoptera are phytophagous insects, and Acridomorpha, or grasshoppers, follow the rule that the more varied the resources, the more diverse the consumers (Uvarov 1997). Moreover, apart from *Anacridium aegyptium*, which feeds on tree foliage, most North African grasshoppers consume herbs (Ould-ElHadj 2002, Mesli 2007, Zaim et al. 2013), which were dominant in the retam plantation.

Interestingly, the different species were not equivalent in terms of rareness, and there was an accumulation of rare species found in the retam plantation. This is remarkable because rare species are important for the functioning of ecosystems (Lyons et al. 2005) and are here linked to less disturbed habitats. In contrast, the tamarix plantation—the habitat with the less stable soil—hosted rather common—and not specialized—species adapted to difficult conditions.

In conclusion, our approach of considering both plants and insects provides integrated information on the various degrees and consequences of dune ecosystem stability. Interestingly, although the Orthoptera assemblage established on retam was quite different from that of other steppe landscapes, the communities of Orthoptera hosted by opuntia and tamarix were close to that of the degraded steppe vegetation of alpha and *Lygeum spartum*. In fact, the rich Orthoptera community in the retam plantation was due to a greater plant diversity at the expense of true sand flora, as remarked in Muñoz-Vallés et al. (2014). The greater annual richness and abundance of annual plants did not seem to depend on the nitrogen content in the soil but rather on a thin layer of fallen leaves that limited the movement of sand. The retam habitat was also notable for a greater number of rare Orthoptera species, indicating a more stable ecosystem.

Declarations of interest

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author roles

BEHS performed the field work. BEHS and AGB identified the specimens and wrote the first draft of the manuscript. AGB directed the work. DP made the final analyzes and wrote the final version of the manuscript.

Acknowledgements

We are appreciative of the editors' diligent editing work and the reviewers' insightful and helpful remarks and suggestions.

References

Adamou AE, Kouidri M, Boutmedjet A, Houyou Z, Ouakid ML (2015) Évaluation d'un projet de fixation de dunes dans une steppe sud–algéroise: Moyen de lutte contre l'ensablement et amélioration de la productivité pastorale. Revue des Régions Arides 36: 221–234.

Aidoud A, Le Floc HE, Le Houérou HN (2006) Les steppes arides du nord de l'Afrique. Sécheresse 17: 19–30.

Akkouche S, Guerrache N, Bouderbala R, Kadik L (2014) Choice of fixing species dunes and their effect on vegetation. International Journal of Innovative and Applied Research 2: 21–30.

Bagnouls F, Gaussen H (1953) Saison sèche et indice xérothermique, document pour les cartes de production végétale. Série généralité cartographique de l'unité écologique. Edward Privat, Toulouse, 239 pp.

Benmadani, Doumandji-Mitiche B, Doumandji S (2011) La faune orthoptérologique en zone semi-aride de la région de Djelfa (Algérie). Actes du Séminaire International sur la Biodiversité Faunistique en Zones Arides et Semi-arides, 7 pp.

Benzécri JP (1992) Correspondence analysis handbook. Marcel Dekker, New York, 665 pp.

Betina SI, Harrat A, Petit D (2017) Analysis of factors involved in grasshopper diversity in arid Aurès mountains (Batna, Algeria). Journal of Entomology and Zoology Studies 5: 339–348.

Bouziane A, Moulaï R, Hamadi K, Petit D (2023) When Grinnelian generalist species are more sensitive to altered habitats than specialists: the case of Orthoptera communities settled in coastal dunes. Annales de la Société Entomologique de France 59: 393–405. https://doi.org/10.1080/00379271.2023.2284168

Chopard L (1943) Orthoptéroïdes de l'Afrique du Nord. Faune de l'empire français 1. Librairie la Rose, Paris, 450 pp.

Cigliano MM, Braun H, Eades DC, Otte D (2024) Orthoptera Species File. [accessed on 29/12/2024] https://orthoptera.speciesfile.org/

Clarke KR (1993) Non-parametric multivariate analyses of changes in community structure. Australian Journal of Ecology 18: 117–143. https://doi.org/10.1111/j.1442-9993.1993.tb00438.x

Daget P (1980) Sur les types biologiques botaniques en tant que stratégie adaptative (cas des thérophytes). In: Barbault R, Blandin P, Meyer JA (Eds) Recherches d'écologie théorique: les stratégies adaptatives. Maloine, Paris, 89–114.

DGF [Direction Générale des Forêts] (2004) Rapport national de l'Algérie sur la mise en œuvre de la Convention de lutte contre la désertification. Direction Générale des Forêts, Algiers. https://www.unccd.int/sites/default/files/prais-legacy/Algeria/2004/Algeria%20-%20ACP%20-%202004%20fre.pdf [Accessed on 20/01/2025]

Djebaili S (1984) Steppes algériennes: phytosociologie et écologie. Ed. OPU, Algiers, 177 pp.

Djebaili S, Djellouli Y, Daget P (1989) Les steppes pâturées des Hauts Plateaux algériens. Fourrages 120: 393–400.

FAO [Food and Agriculture Organisation] (1988) Manuel de fixation des dunes. Danina, Rome, 57 pp.

Grunshaw JP (1991) A revision of the grasshopper genus *Heteracris* (Orthoptera: Acrididae: Eyprepocnemidinae). Bulletin 38. Natural Resources Institute, Chatham Maritime, Kent, UK, 106 pp. http://gala.gre.ac.uk/id/eprint/11108

Guerrache N, Akkouche S, Kadik L (2014) Evaluation of the biodiversity and stabilization of the soil after the fixating of the dunes by *Retama retam* Webb., *Tamarix gallica* L. and *Tamarix aphylla* (L.) karst in the dunes cordon of El-Mesrane (W. Djelfa) in Algeria. African Journal of Agricultural Research 9: 1467–1479. https://doi.org/10.5897/AJAR2014.8518

Guerzou A, Boukraa S, Souttou K, Derdoukh W, Guerzou M, Sekour M, Baziz-Neffah F, Domandji SE (2012) Place des insectes dans le régime alimentaire du Grand Corbeau *Corvus corax* (Aves, Corvidae) dans la région de Guelt-es-Stel (Djelfa, Algérie). Entomologie faunistique – Faunistic Entomology 64: 49–55. https://hdl.handle.net/2268/112261

Hafayed R, Moussi A, Chang H, Huang Y (2023) Species delimitation and molecular phylogeny of the grasshopper subfamily Gomphocerinae (Orthoptera: Acrididae) from Algeria based on mitochondrial and nuclear DNA markers. African Zoology 58: 80–96. https://doi.org/10.1080/15627020.2023.2263498

Hammer Ø, Harper DAT, Ryan PD (2001) Past: palaeontological statistics software package for education and data analysis Palaeont Electron., 4(1) art. 4, 9 pp. https://palaeo-electronica.org/2001_1/past/past.pdf

Julve P (1998) Baseveg. Index phytosociologique synonymique de la végétation de la France. Version: « 14 août 2014 ». [Programme Catminat accessed on 19/01/2016, now transferred to eVeg at] https://www.e-veg.net/accueil

Kaabèche M (2000) Guide des habitats aride et saharien (Typologie phytosociologique de la végétation d'Algérie). In: Conservation de la biodiversité et gestion durable des ressources naturelles, Abbas University, Sétif, Algeria, 59 pp. https://www.doc-developpement-durable.org/file/Culture/Fertilisation-des-Terres-et-des-Sols/sols-arides/Guide%20des%20Habitats%20Aride%20et%20Saharien%20Algerie.pdf

Kacimi B (1996) La problématique du développement des zones steppiques. Approche et perspectives. Doc. HCDS, Ministère de l'agriculture, 27 pp.

Khatteli H, Akrimi N (1997) A method for the mechanical stabilisation of moving sand-dunes in pre-Saharan area of southern Tunisia. Prospettive e proposte mediterranee - Rivista di Economia, Agricoltura e Ambiente 1: 14–19.

Le Houérou HN (1996) The role of cacti (*Opuntia* spp.) in erosion control, land reclamation, rehabilitation and agricultural development in the Mediterranean Basin. Journal of Arid Environments 33: 135–159. https://doi.org/10.1006/jare.1996.0053

Le Houérou HN (2000) Restoration and rehabilitation of arid and semi-arid Mediterranean ecosystems in North Africa and West Asia: A review. Arid Soil Research and Rehabilitation 14: 3–14. https://doi.org/10.1080/089030600263139

Le Houérou HN (2002) Man-made deserts: desertification processes and threats. Arid Land Research and Management 16: 1–36. https://doi.org/10.1080/153249802753365296

Li XR, Xiao HL, Zhang JG, Wang XP (2004) Long-term ecosystem effects of sand-binding vegetation in the Tengger Desert, northern China. Restoration Ecology 12: 376–390. https://doi.org/10.1111/j.1061-2971.2004.00313.x

Li X, Xiao HL, He MZ, Zhang GJ (2006) Sand barriers of straw checkerboards for habitat restoration in extremely arid desert region of China. Ecological Engineering 28: 149–157. https://doi.org/10.1016/j.ecoleng.2006.05.020

Li X, Zhang Z, Tan H, Gao Y, Liu L, Wang X (2014) Ecological restoration and recovery in the wind-blown sand hazard areas of northern China: relationship between soil water and carrying capacity for vegetation in the Tengger Desert. Science China Life Sciences 57: 539–548. https://doi.org/10.1007/s11427-014-4633-2

Louveaux A, Amedegnato C, Poulain S, Desutter Grandcolas L (2024) Acridomorpha de l'Afrique du Nord-Ouest. [accessed on 29/12/2024] http://acrinwafrica.mnhn.fr

Lyons KG, Brigham CA, Traut BH, Schwartz MW (2005) Rare species and ecosystem functioning. Conservation Biology 19: 1019–1024. https://doi.org/10.1111/j.1523-1739.2005.00106.x

Mahdjoubi D, Guendouz-Benrima A, Petit D (2017) Plant communities and solitary Desert Locust abundance in the Algerian Sahara, compared to other African countries. Phytocoenologia 47: 125–137. https://doi.org/10.1127/phyto/2017/0124

Mahloul S, Harrat A, Petit D (2016) Diversity of grasshoppers (Caelifera) recorded on the banks of a Ramsar temporary salt lake in Algeria. European Journal of Entomology 113: 158–172. https://doi.org/10.14411/eje.2016.020

Mathieu C, Pieltain F (2003) Analyse chimique des sols, Méthodes choisies. Tec et Doc Lavoisier, Paris, 388 pp.

Mesli L (2007) Contribution à l'étude bioécologique et régime alimentaire des principales espèces d'orthoptères dans la wilaya de Tlemcen. Thès. Doc. Univ. Tlemcen (Algeria), 102 pp.

Moussi A, Abba A, Harrat A, Petit D (2011) Desert acridian fauna (Orthoptera, Acridomorpha): comparison between steppic and oasian habitats in Algeria. Comptes Rendus Biologies 334: 158–167. https://doi.org/10.1016/j.crvi.2010.12.001

Moussi A, Dey LS, Abba A, Klesser R, Petit D, Husemann M (2018) First genetic data for band-winged grasshoppers (Orthoptera: Acrididae: Oedipodinae) of the Biskra region of Algeria with new records for the country. African Zoology 53: 31–40. https://doi.org/10.1080/15627020.2018.1463172

Muñoz-Vallés S, Gallego-Fernández JB, Cambrollé J (2014) The role of the expansion of native-invasive plant species in coastal dunes: The case of *Retama monosperma* in SW Spain. Acta Oecologica 54: 82–89. https://doi.org/10.1016/j.actao.2012.12.003

Nedjraoui D, Bédrani S (2008) La désertification dans les steppes algériennes: causes, impacts et actions de lutte. VertigO 8(1). https://doi.org/10.4000/vertigo.5375

Neffar S, Chenchouni H, Beddiar A, Redjel N (2013) Rehabilitation of degraded rangeland in drylands by Prickly Pear (*Opuntia ficus-indica* L.) plantations: Effect on soil and spontaneous vegetation. Ecologia Balkanica 5: 63–76.

Ould ElHadj D (2002) Etude du régime alimentaire de cinq espèces d'acridiens dans les conditions naturelles de la cuvette de Ouargla (Algérie). L'entomologiste 58: 197–209.

Ozenda P (1991) Flore et végétation du Sahara. CNRS, Paris, 662 pp. https://doi.org/10.1016/S0016-6995(06)80408-0

Pouget M (1980) Les relations sol-végétation dans les steppes sud-algéroises. ORSTOM, Paris, 555 pp. (Travaux et Documents de l'ORSTOM, 116). https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers07/00344.pdf

Quézel P, Santa S (1961, 1962) Nouvelle flore de l'Algérie et des régions désertiques méridionales. Volumes 1 and 2. CNRS, Paris, 1170 pp.

Raunkiaer C (1934) The life form of plants and statistical plant geography. Collected papers. Clarendon Press, Oxford, 632 pp.

Sba BEH, Benrima A (2017) Biodiversité acridienne et floristique en milieux steppiques naturels et reboisés dans la région de Moudjbara-Djelfa (Algérie). Agrobiologia 7: 321–333.

Sobhi Z, Allal-Benfekih L, Petit D (2013) Biodiversité acridienne des zones humides et des écosystèmes forestiers (de *Quercus suber* et de *Q. canariensis*): Effets du climat et de la végétation. Bulletin de la Société Zoologique de France 138: 229–250.

Souttou K, Manaa A, Baziz-Neffah F, Sekour M, Doumandji S, Denys C (2011) Relations entre les disponibilités trophiques et le régime alimentaire du Faucon crécerelle: application de l'indice de sélection. Sciences & Technologie. C, Biotechnologies 33: 62–70.

Uvarov B (1977) Grasshoppers and locusts: a handbook of general acridology, 2. Anti-Locust Research Centre (Great Britain), 613 pp.

Zaim A, Petit D, El Ghadraoui L (2013) Dietary diversification and variations in the number of labrum sensilla in grasshoppers: which came first? Journal of Biosciences 38: 339–349. https://doi.org/10.1007/s12038-013-9325-8

Zhang J, Zhao H, Zhang T, Zhao X, Drake S (2015) Community succession along a chronosequence of vegetation restoration on sand dunes in Horqin Sandy Land. Journal of Arid Environments 62: 555–566. https://doi.org/10.1016/j.jaridenv.2005.01.016

Appendix 1

Table A1. Mean abundances of plant species within the three plantations (Opuntia, Tamarix, and Retam).

Family	Species	Psammo-phyte groups	Opuntia	Tamarix	Retam
Asteraceae	*Artemisia campestris* L.	2	3	2	0
	Filago argentea (Pomel) Chrtek & Holub (1963)		0	0	5
	Galactites tomentosus Moench	1	0	0	3
	Helichrysum stoechas (L.) Moench		0	0	2
	Leontodon saxatilis Lam.		0	0	2
	Pulicaria undulata (L.) C.A.Mey.		0	1	0
	Scorzoneroides muelleri (Sch.Bip.) Greuter & Talavera		0	0	2
	Senecio glaucus subsp. *coronopifolius* Maire	1	0	0	5
	Senecio leucanthemifolius Poir.		4	5	1
	Sonchus oleraceus L.		2	0	0
Poaceae	*Anisantha rubens* (L.) Nevski		0	2	0
	Anisantha sterilis (L.) Nevski	1	4	0	4
	Hordeum murinum L.	1	0	0	1
	Lolium multiflorum Lam		0	2	0
	Lolium rigidum (Gaudin)	1	5	2	2
	Rostraria litorea (All.) Holub		0	1	0
	Schismus barbatus (L.) Thell.	1	0	0	1
	Stipagrostis pungens (Desf.) De Winter	3	0	3	0
Fabaceae	*Retama raetam* (Forssk.) Webb	2	0	0	2
	Medicago minima (L.) L.		0	0	2
	Medicago laciniata (L.) Mill.		0	1	0
	Ononis natrix L.	3	2	0	1
	Vicia villosa Roth		2	0	0
Amaranthaceae	*Atriplex canescens* (Pursh) Nutt		3	2	0
	Bassia muricata (L.) Asch.	1	3	0	0
Brassicaceae	*Eruca vesicaria* L.	2	0	0	4
	Pseuderucaria teretifolia (Desf.) O.E.Schulz	3	0	0	1
Caprifoliaceae	*Lomelosia stellata* (L.) Raf.		2	0	0
	Sixalix arenaria (Forssk.) Greuter & Burdet	2	2	0	2
Lamiaceae	*Saccocalyx satureioides* Coss. & Durieu	3	3	2	0
	Salvia verbenaca L.		1	0	0
Plantaginaceae	*Plantago afra* L.		2	0	0
	Plantago albicans L.	2	3	0	3
Boraginaceae	*Echium trygorrhizum* Pomel		1	0	1
Caryophyllaceae	*Paronychia arabica* (L.) DC.	1	0	1	0
Cactaceae	*Opuntia ficus-indica* (L.) Mill.		2	0	0
Cistaceae	*Helianthemum hirtum* (L.) Mill.		0	1	0
Cyperaceae	*Cyperus* sp.		0	1	0
Euphorbiaceae	*Euphorbia guyoniana* Boiss. & Reut.	3	1	2	0
Geraniaceae	*Erodium glaucophyllum* (L.) L'H.		2	0	2
Papaveraceae	*Hypecoum geslinii* Coss. & Kralik		0	2	1
Rhamnaceae	*Ziziphus lotus* L.		1	0	0
Resedaceae	*Reseda lutea* L.		0	0	1
Scorophulariaceae	*Scrophularia syriaca* A.DC.		0	2	0
Tamaricaceae	*Tamarix gallica* L.	1	0	1	0
Thymeleaceae	*Thymelaea microphylla* Coss. & Durieu		2	0	0

Appendix 2

Table A2. Inventory of grasshoppers recorded in the three stations of El Mesrane.

Family	Subfamily	Species	Code	RETAM	OPUNTIA	TAMARIX
Acrididae	Oedipodinae	*Acrotylus insubricus* (Scopoli, 1786)	Acrin	0	1	0
		Acrotylus longipes (Charpentier, 1845(1841))	Acrlo	2	0	0
		Acrotylus patruelis (Herrich-Schäffer, 1838)	Acrpa	7	8	6
		Aiolopus puissanti Defaut, 2005	Aiolpui	0	5	0
		Leptopternis maculata (Vosseler, 1902)	Lepmac	6	0	0
		Oedaleus decorus (Germar, 1826)	Oedde	0	1	1
		Oedipoda caerulescens sulfurescens Saussure, 1884	Oedsulf	0	0	1
		Oedipoda fuscocincta Lucas, 1849	Oedfus	2	0	0
		Oedipoda miniata mauritanica Lucas 1849	Oedmin	4	2	3
		Sphingoderus carinatus (Saussure, 1888)	Sphica	1	0	0
		Sphingonotus azurescens (Rambur, 1838)	Sphiaz	6	2	2
		Sphingonotus lucasii Saussure, 1888	Sphiluc	6	1	0
		Sphingonotus rubescens rubescens (Walker, 1870)	Sphirub	2	0	1
	Acridinae	*Truxalis nasuta* (L. 1758)	Acrina	3	1	1
	Gomphocerinae	*Dociostaurus jagoi jagoi* Soltani, 1978	Docja	6	4	5
		Ochrilidia gracilis (Krauss, 1902)	Ochgra	0	0	0
		Ochrilidia harterti (Bolivar, 1913)	Ochhart	0	0	0
		Omocestus africanus Harz, 1970	Omoafri	3	1	0
		Omocestus lucasii (Brisout de Barneville, 1850)	Omoluc	7	1	1
		Ramburiella hispanica (Rambur, 1838)	Ramhis	1	2	1
	Dericorythinae	*Dericorys millierei* Bonnet & Finot, 1884	Derimil	2	1	0
		Egnatioides coerulans (Bei-Bienko & Mishchenko, 1951)	Egnco	5	0	0
	Cyrtacanthacridinae	*Anacridium aegyptium* (L., 1764)	Anaeg	0	4	1
	Calliptaminae	*Calliptamus barbarus* (Costa, 1836)	Calbar	7	3	2
Pyrgomorphidae	Pyrgomorphinae	*Pyrgomorpha conica* (Olivier, 1791)	Pyrconi	3	3	1
		Pyrgomorpha cognata Krauss, 1877	Pyrcogna	6	5	3
		Euryparyphes sitifensis (Brisout de Barneville, 1854)	Eurisi	0	1	0
Pamphagidae	Pamphaginae	*Paracinipe saharae* (Pictet & Saussure, 1893(1891))	Parasah	0	2	0
		Paraeuryparyphes quadridentatus (Brisout de Barneville, 1852)	Parqua	1	0	0
	Trinchinae	*Tmethis pulchripennis* (Serville, 1839)	Tmepu	4	5	3
		Tmethis cisti (Fabricius, 1787)	Tmecis	0	0	0
Tettigoniidae	Phaneropterinae	*Platycleis affinis* Fieber, 1853	Plaaf	1	1	0

Supplementary material 1

Author: Bent El Hadi Sba, Imene Djemai, Daniel Petit, Atika Guendouz Benrima
Data type: docx
Explanation note: Data 1. Biogeographic elements in the three plantations. Data 2. Cluster analysis of the 10 samplings by habitat and plant species using the Ward's method of ordination. RET1, RET2,… TAM11, TAM12,… and OPU21, OPU22,… correspond to retam, tamarix and opuntia samplings, respectively.
Copyright notice: This dataset is made available under the Open Database License (http://opendatacommons.org/licenses/odbl/1.0/). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.
Link: https://doi.org/10.3897/jor.34.137800.suppl1